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BSC user case study on data assimilation

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Outline

- **A new user case study**
- **Introducing BSC-ES**
- **A first assimilation test with the IASI IMARS retrievals**



A new user case study

Assimilation of Aerosol_cci IASI Dust AOD into the NMMB/BSC-Dust model

- Show the potential of assimilating dust AOD observations from IASI into a dust forecast model;
- Assess the usefulness of Aerosol_cci products for mineral dust simulations, and the potential benefit of dedicated dust observation products from satellite;
- Evaluate the potential benefit of using aggregated dust information from the full range of Aerosol_cci IASI dust products compared to the use of single products.

- Description of the usability of Aerosol_cci products for data assimilation purposes;
- Feedback from the assimilation team into the group of product developers by close interaction;
- Description of the impact of the different dust AOD products on simulation results;
- Guidelines for the future development of dedicated dust observation products tailored for data assimilation.



Introducing BSC-ES

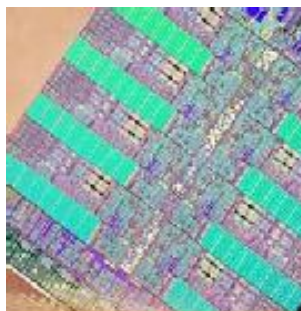


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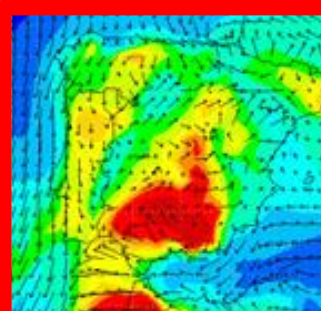


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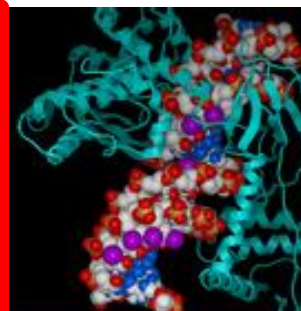
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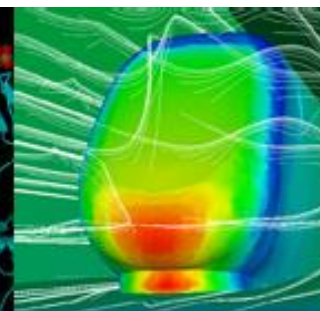
COMPUTER
SCIENCES



EARTH
SCIENCES



LIFE
SCIENCES



COMPUTER
APPLICATIONS

What

Environmental modelling and forecasting



Supercomputing facilities

How

Develop a capability to model atmospheric composition processes from urban to global and the impacts on weather, health and ecosystems

Implement climate prediction system for subseasonal-to-decadal climate prediction

Develop user-oriented services that favour both technology transfer and adaptation

Use cutting-edge HPC and Big Data technologies for the efficiency and user-friendliness of Earth system models

Earth system
services

Climate
prediction

Atmospheric
composition

Computational
Earth sciences

- ✓ Daily dust operational forecast (global and regional)

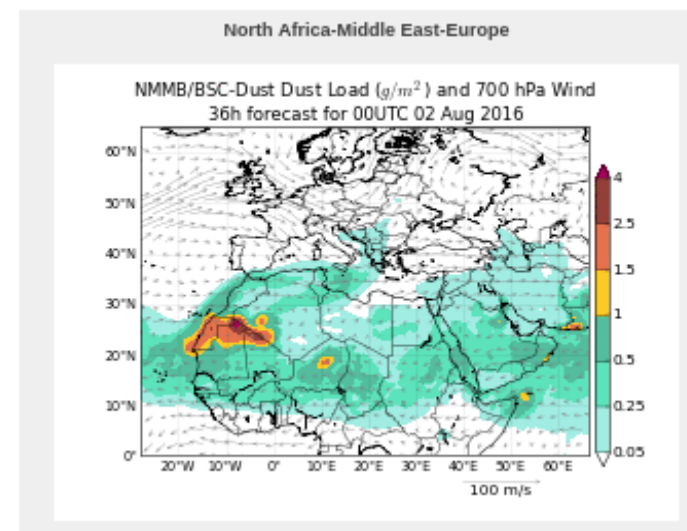
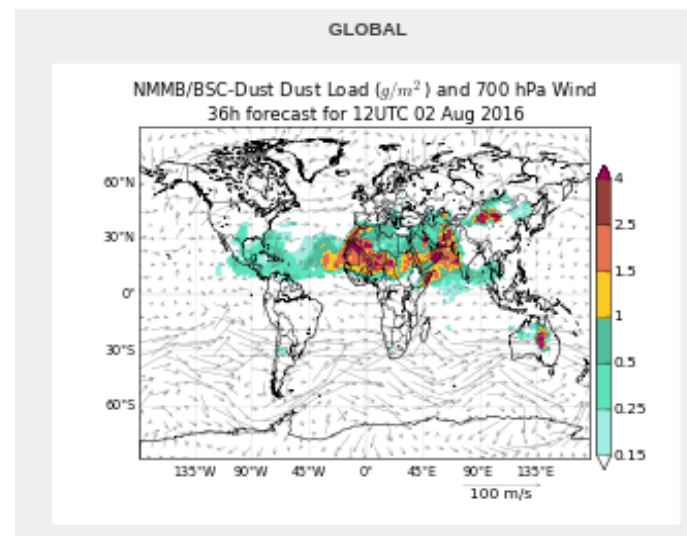
<http://www.bsc.es/earth-sciences/mineral-dust/nmmbbsc-dust-forecast>

- ✓ Contribution to the ICAP multi-model ensemble (global)

<http://icap.atmos.und.edu>

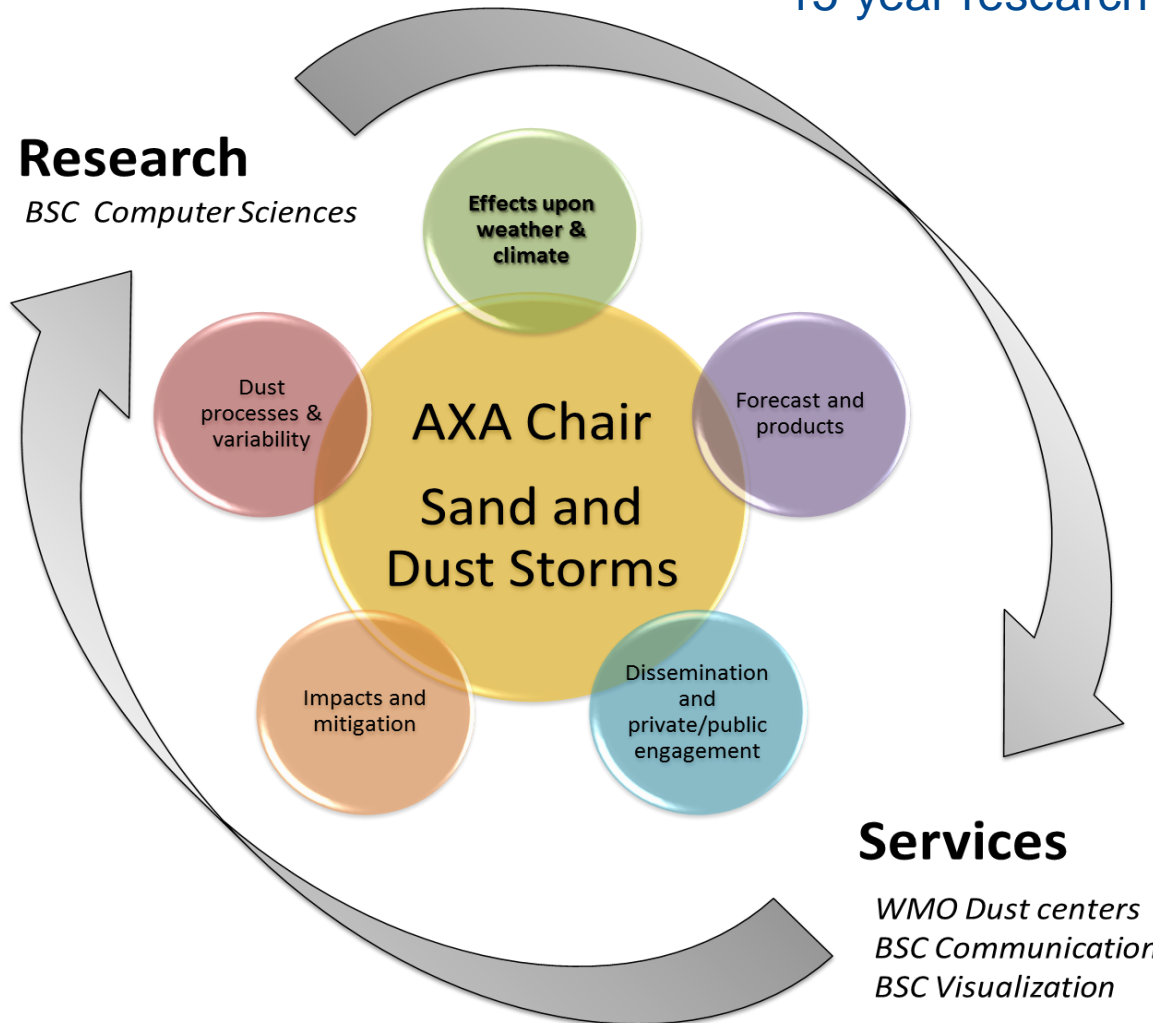
- ✓ **WMO Dust Centers**

- Sand and Dust Storm Warning Advisory and Assessment System Regional Center for North Africa, Middle East and Europe (SDS-WAS RC) <http://sds-was.aemet.es>
- Barcelona Dust Forecast Center (BSFC): First specialized WMO Center for mineral dust prediction <http://dust.aemet.es>

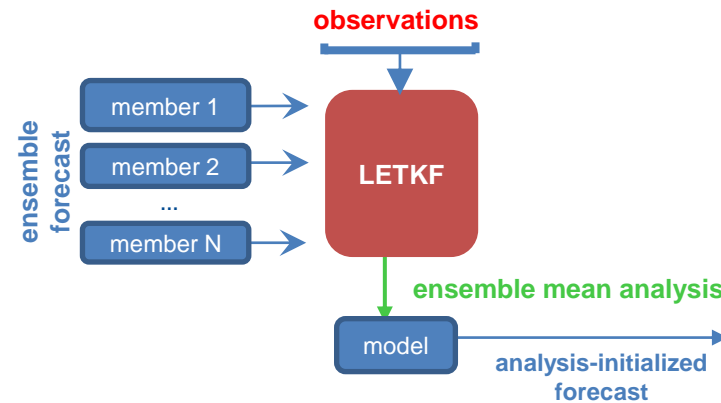


Started October 2016

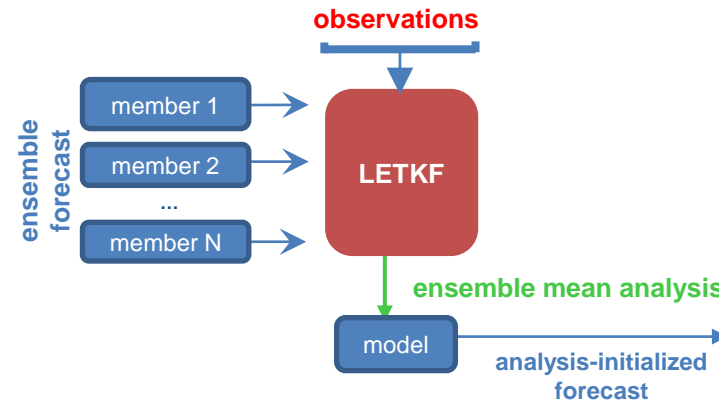
15-year research program funded by AXA



We use an ensemble-based data assimilation scheme (**LETKF**)



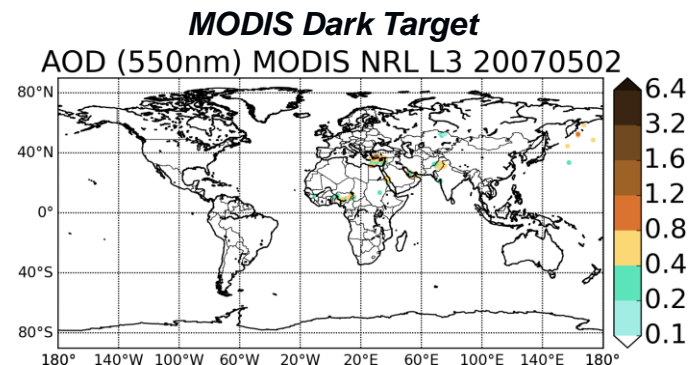
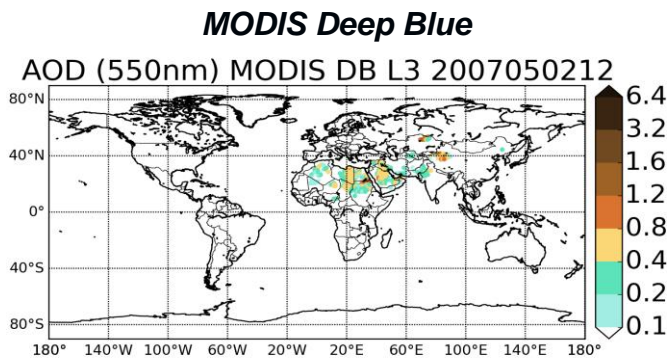
We use an ensemble-based data assimilation scheme (**LETKF**)



Mineral dust application

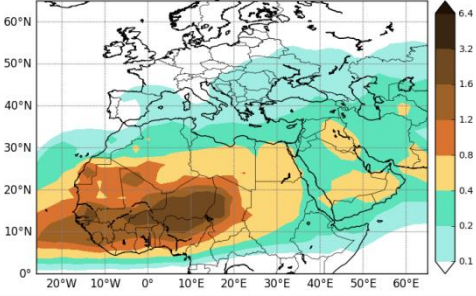
The ensemble forecast is based on some known uncertainties in the dust emission scheme: vertical flux, size distribution at emission, threshold on friction velocity

Assimilated satellite observations, filtered for dust

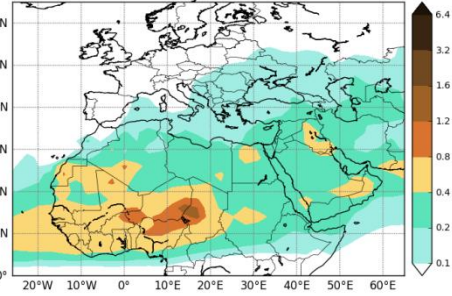


Model simulations without/with DA

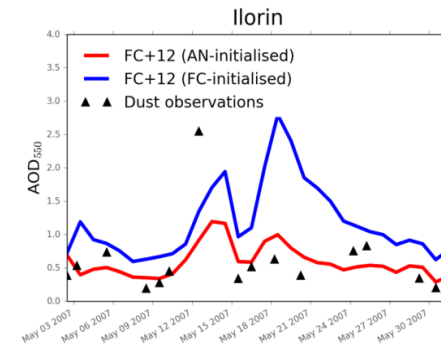
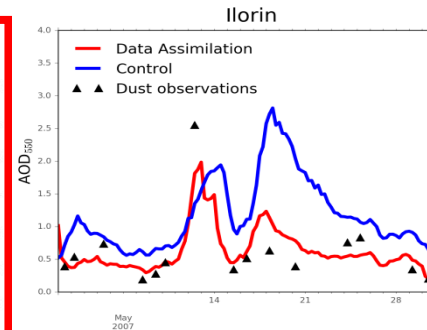
Dust AOD (550nm), Control Simulation
May 2007



Dust AOD (550nm), DA Simulation
May 2007



AERONET Validation

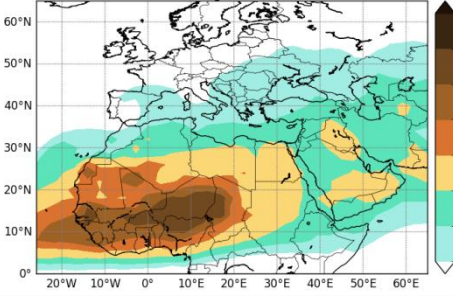


Better description of current and forecast conditions for dust with data assimilation

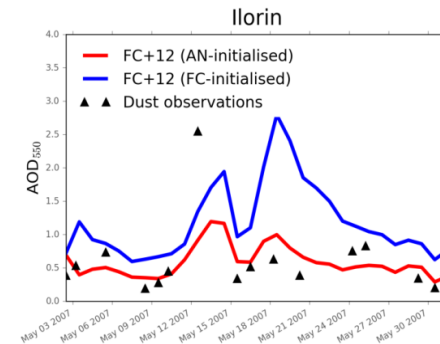
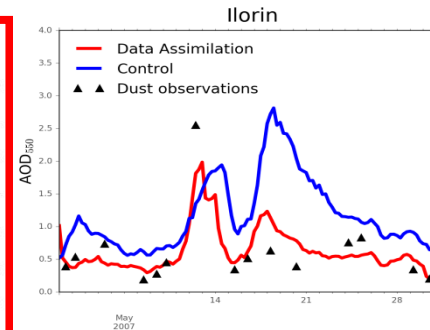
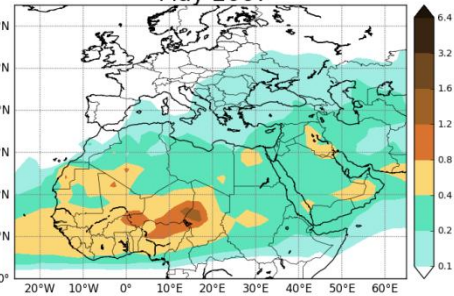
Model simulations without/with DA

AERONET Validation

Dust AOD (550nm), Control Simulation
May 2007



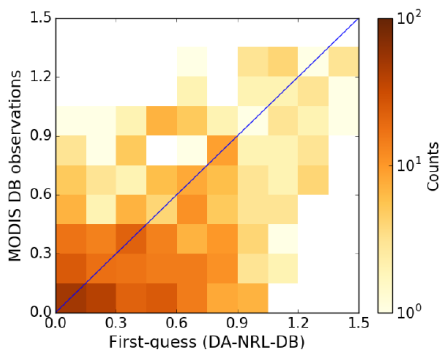
Dust AOD (550nm), DA Simulation
May 2007



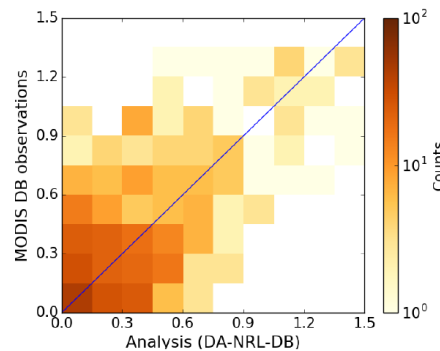
Better description of current and forecast conditions for dust with data assimilation

Related to yesterday's discussions:

MODIS Deep Blue

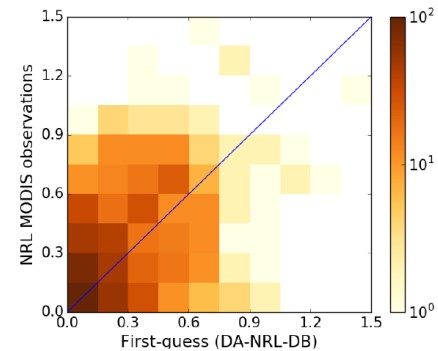


FG

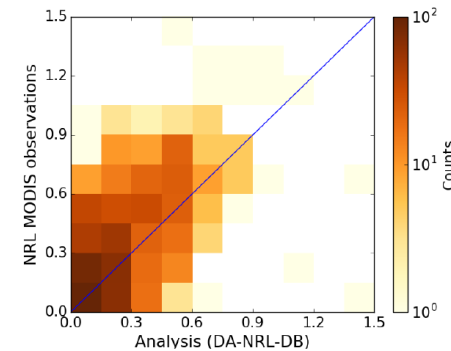


AN

MODIS Dark Target



FG



AN

Di Tomaso, E., Schutgens, N. A. J., Jorba, O., and Pérez García-Pando, C.: Assimilation of MODIS Dark Target and Deep Blue observations in the dust aerosol component of NMMB/BSC-CTM version 1.0, *Geosci. Model Dev. Discuss.*, doi:10.5194/gmd-2016-206, in review, 2016.

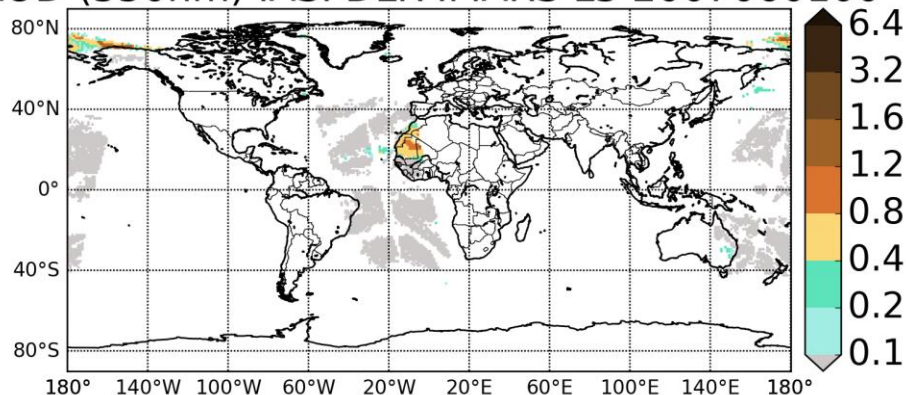


A very first test assimilating IASI IMARS retrievals

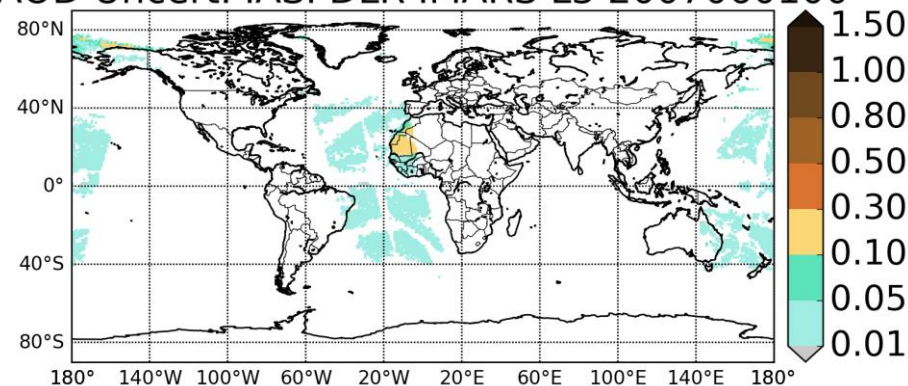
in collaboration with Lars Klüser (DLR)

IASI dust AOD and uncertainty

AOD (550nm) IASI DLR IMARS L3 2007060100



AOD Uncert. IASI DLR IMARS L3 2007060100



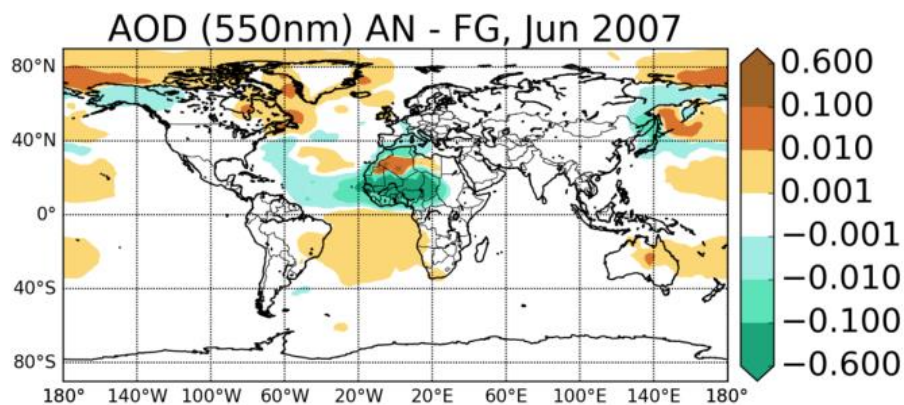
Sub-daily set of mineral dust retrievals with the IMARS algorithm:

- Level-3 aggregated dataset at 1° resolution;
- Source: IASI IMARS L2 ESA Aerosol_cci ;
- Product version v5.2.

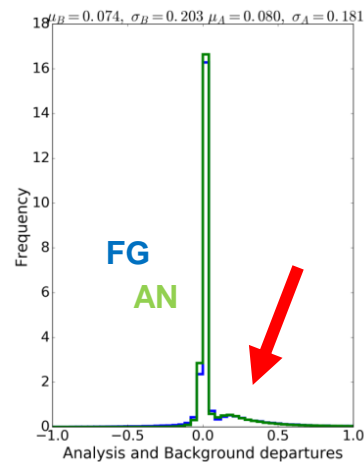
Experiment	Assimilated Observations	Ensemble Configuration	Other settings
CTL	none	No	cold start and 1 month spin-up
ENS-free-run	none	Yes	warm start from CTL and spin-up
IMARS	IMARS L3	Yes	warm start from ENS-free-run
IMARS_QC	Filtered IMARS L3	Yes	warm start from ENS-free-run
IMARS_QC+DT	Filtered IMARS plus MODIS Dark Target L3	Yes	warm start from ENS-free-run
DT+DB	<i>Filtered MODIS Dark Target plus MODIS Deep Blue</i>	Yes	<i>warm start from ENS-free-run</i>

Increments and departures

IMARS Exp

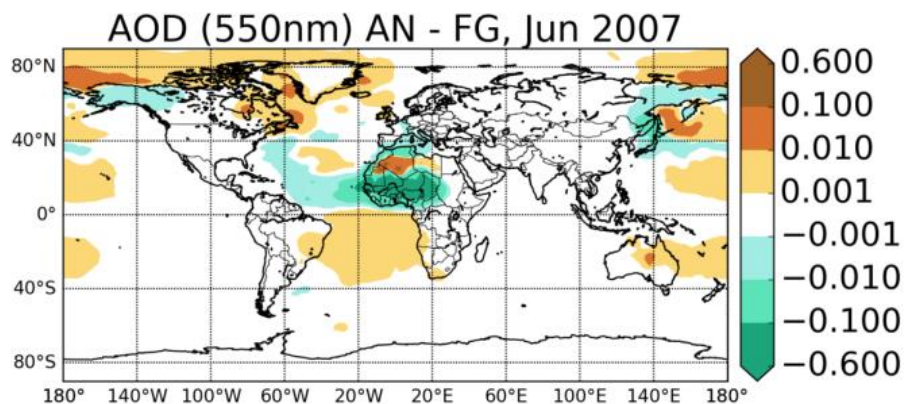


Increments also in areas not expected

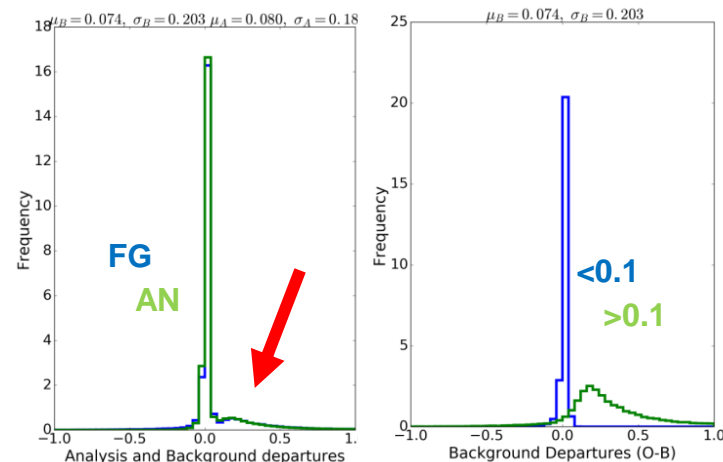


Increments and departures

IMARS Exp

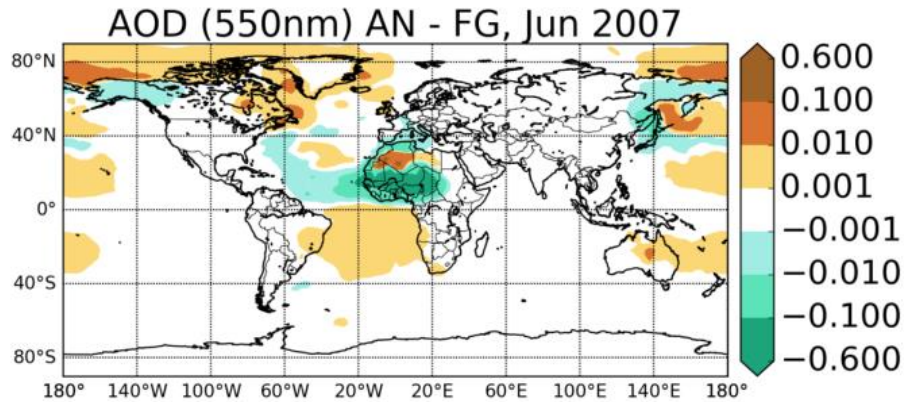


Increments also in areas not expected

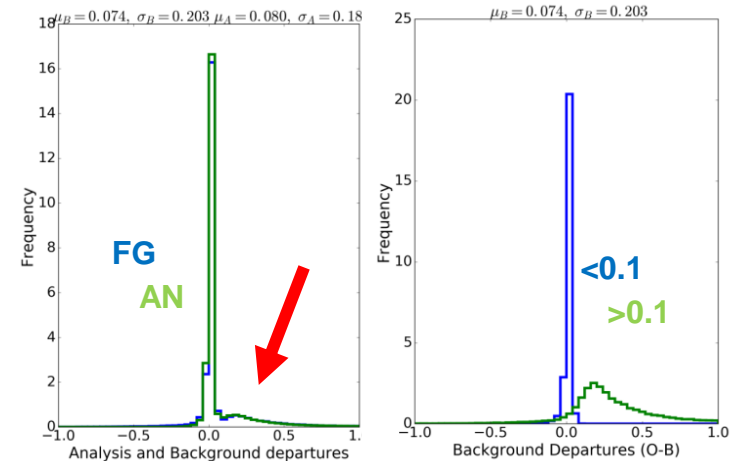


Observations with small and high values of AOD show a different behaviour

IMARS Exp



Increments also in areas not expected



Observations with small and high values of AOD show a different behaviour

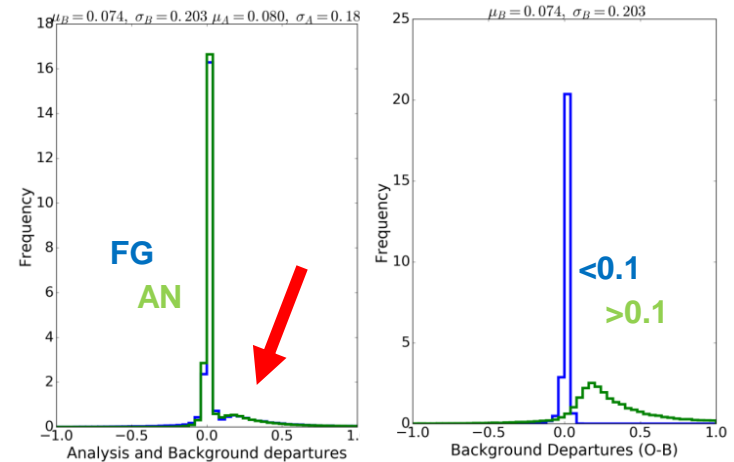
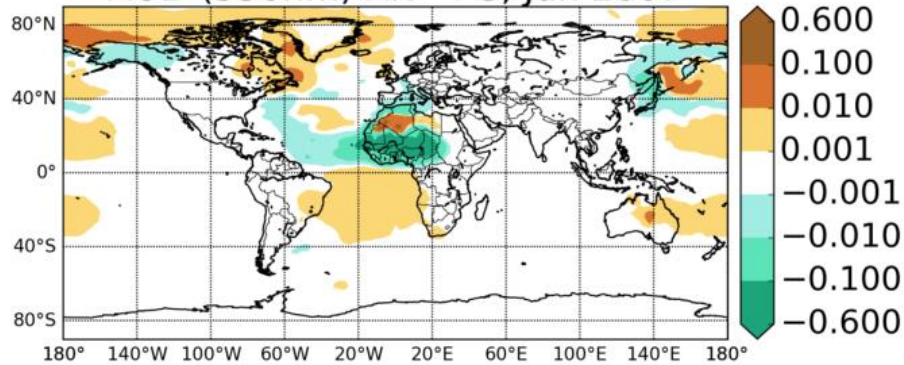
We applied some quality control on the observations

- Threshold on effective emission temperature of dust layer (retrievals sensitivity to volcanic ash, can partially explain what we have seen yesterday AOD-FM != DAOD)
- Threshold on AOD (sensitivity analysis shows low accuracy below 0.15)

Increments and departures

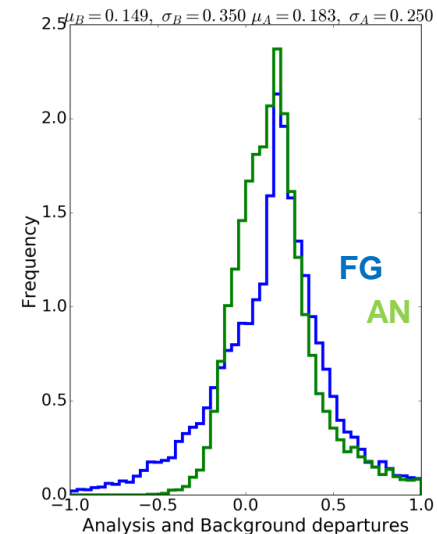
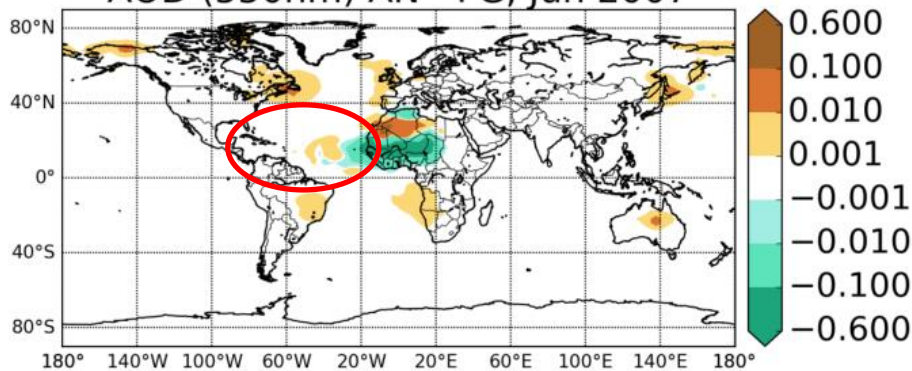
IMARS Exp

AOD (550nm) AN - FG, Jun 2007



IMARS_QC Exp

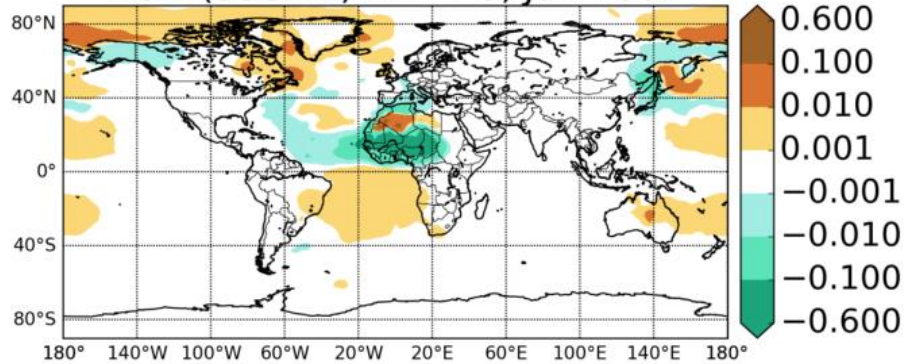
AOD (550nm) AN - FG, Jun 2007



Increments and departures

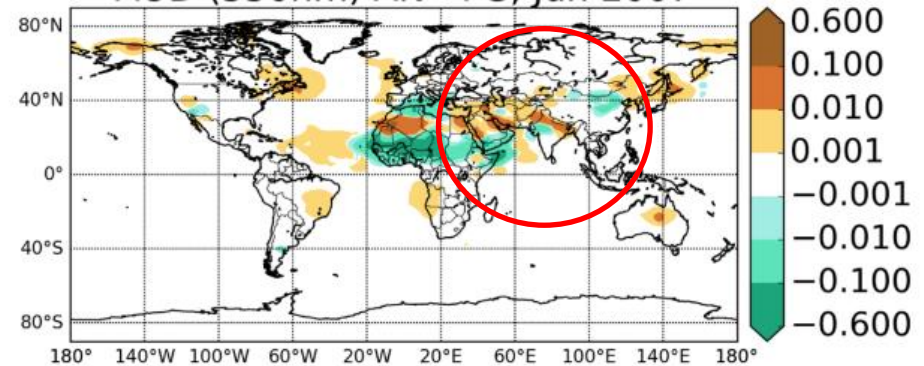
IMARS Exp

AOD (550nm) AN - FG, Jun 2007



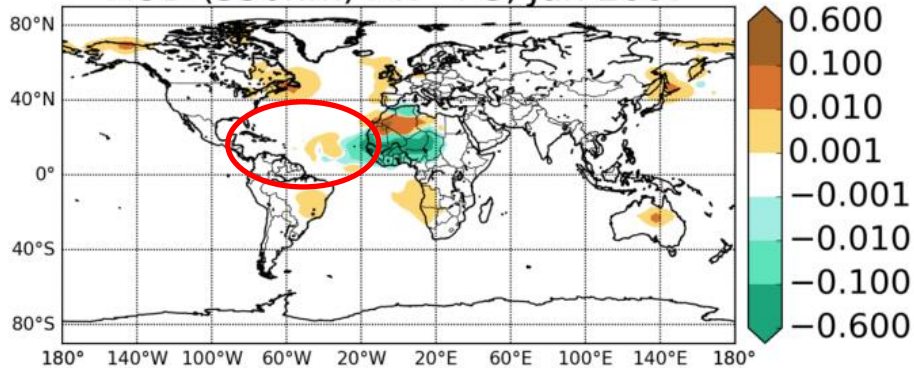
IMARS_QC + DT Exp

AOD (550nm) AN - FG, Jun 2007



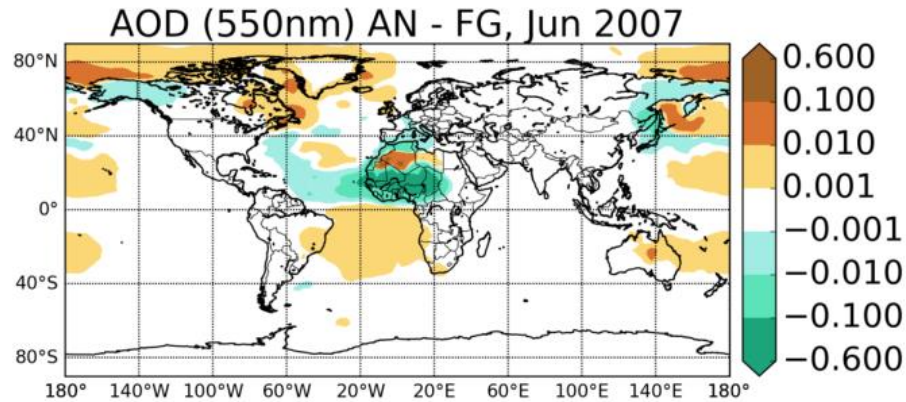
IMARS_QC Exp

AOD (550nm) AN - FG, Jun 2007

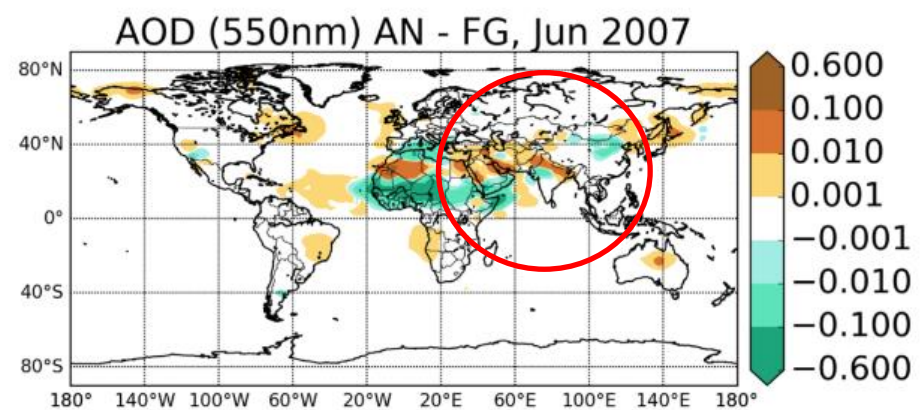


Increments and departures

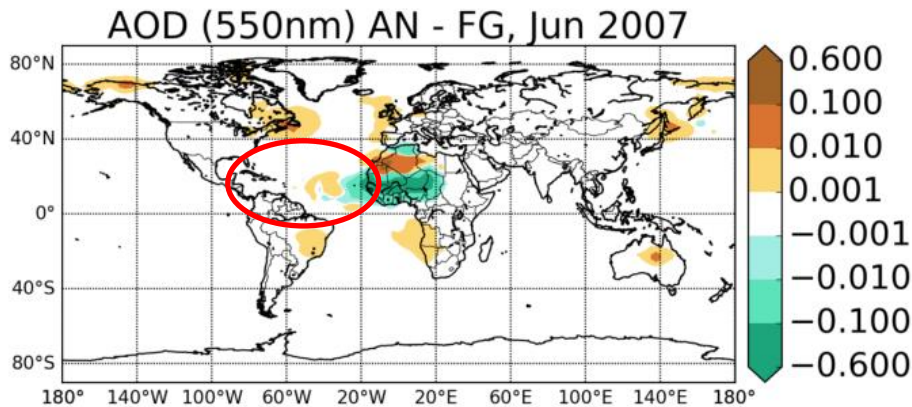
IMARS Exp



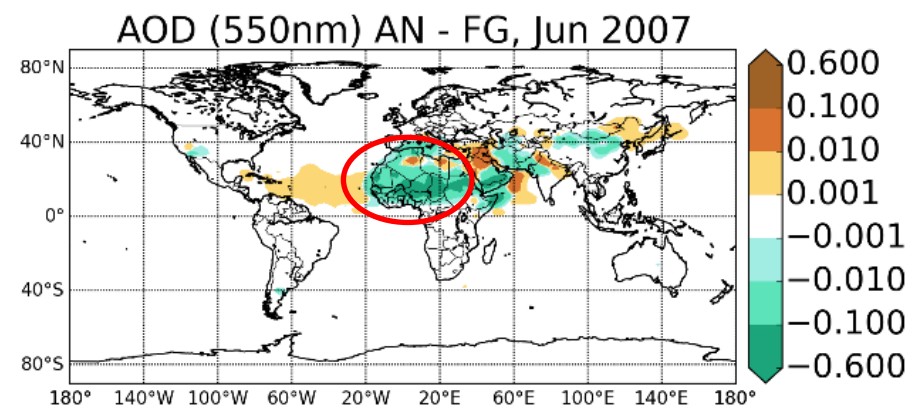
IMARS_QC + DT Exp



IMARS_QC Exp



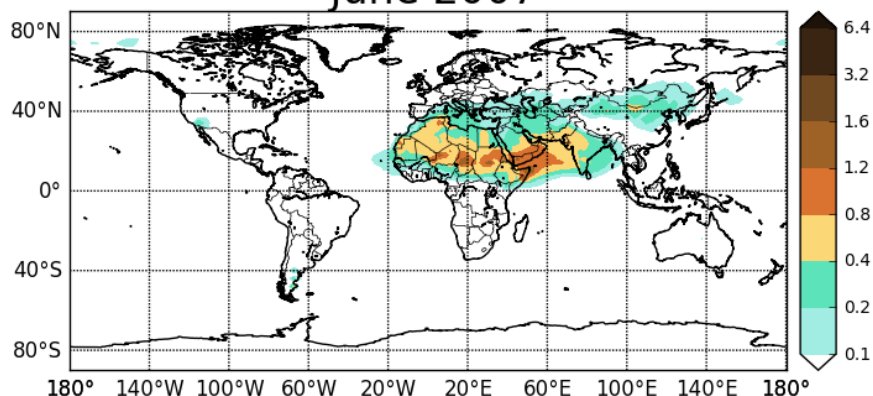
DT + DB Exp



Monthly mean dust AOD analysis

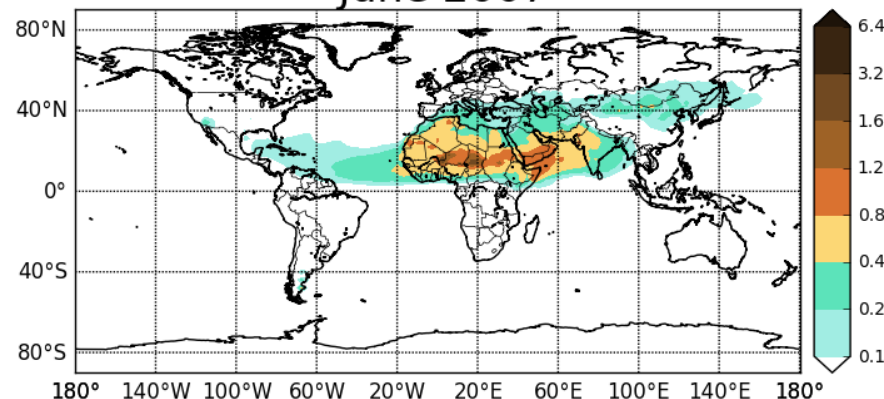
IMARS Exp

Dust AOD (550nm), DA Simulation (IMARS) June 2007



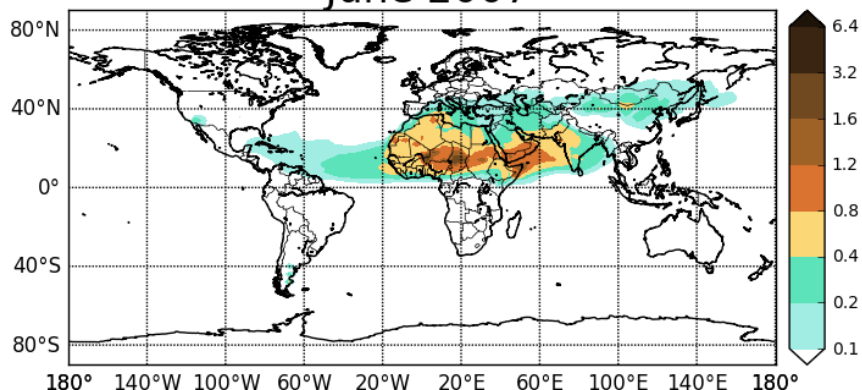
IMARS_QC + DT Exp

Dust AOD (550nm), DA Simulation (IMARS+DT) June 2007



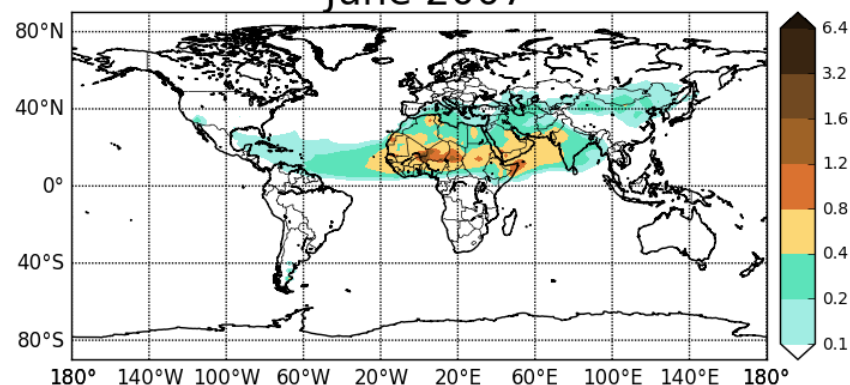
IMARS_QC Exp

Dust AOD (550nm), DA Simulation (IMARS) June 2007



DT + DB Exp

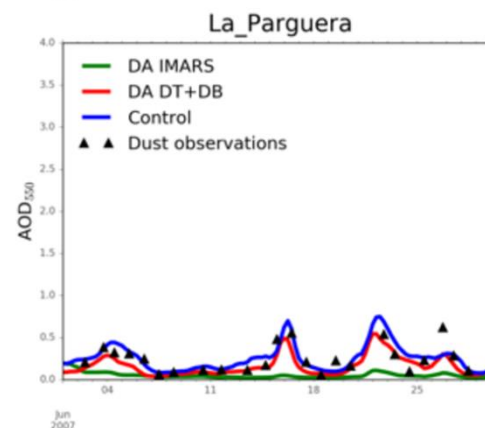
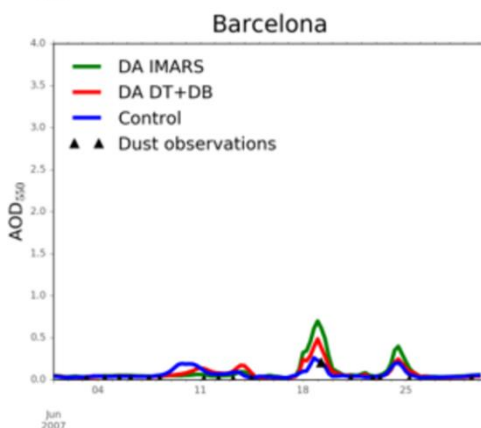
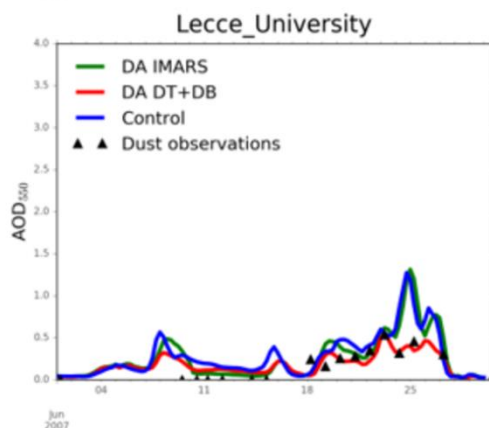
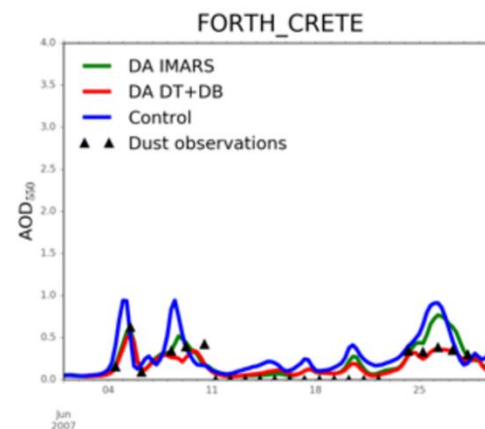
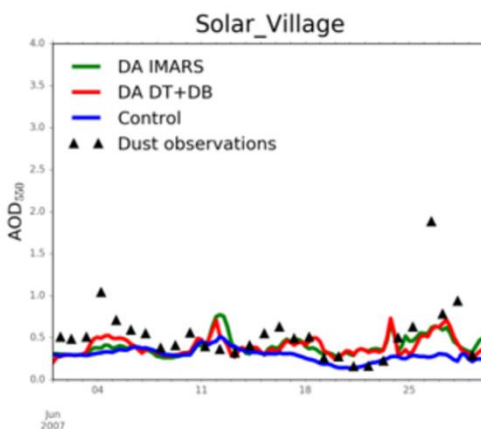
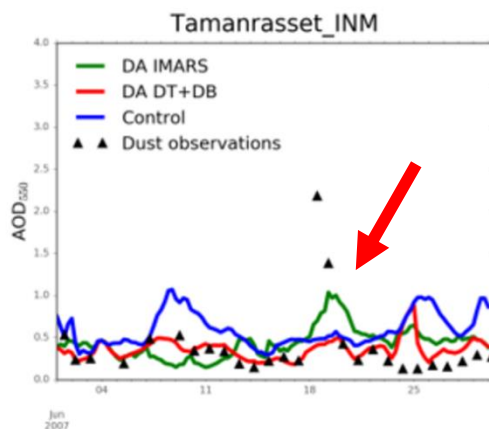
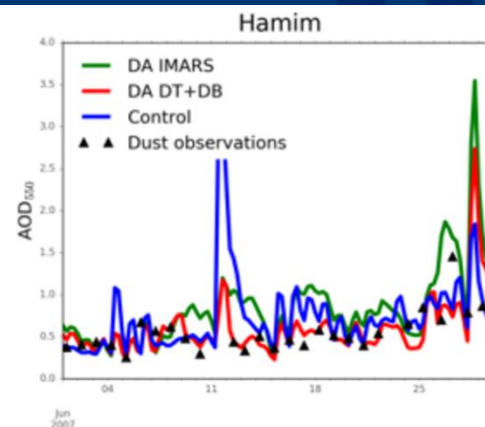
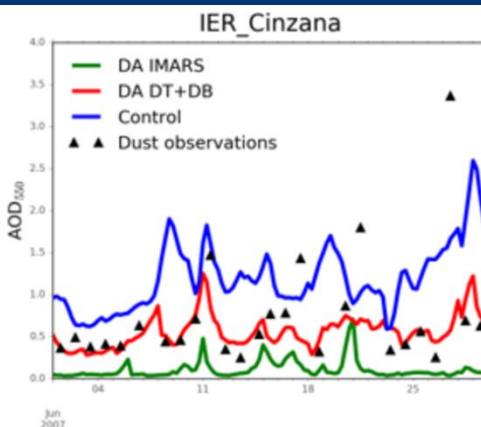
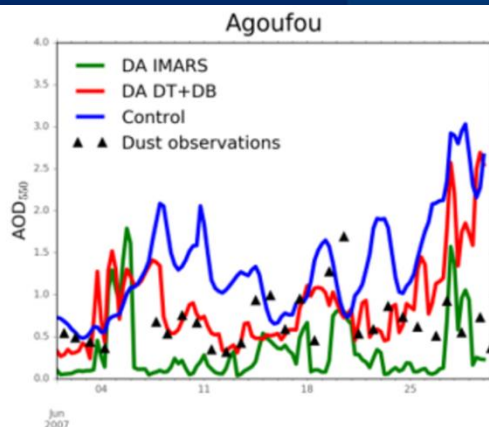
Dust AOD (550nm), DA Simulation (DT+DB) June 2007



Comparison with AERONET



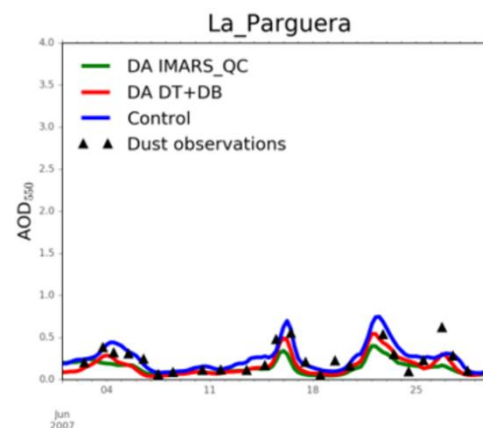
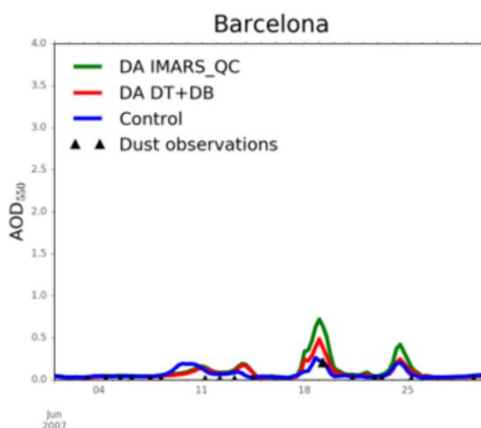
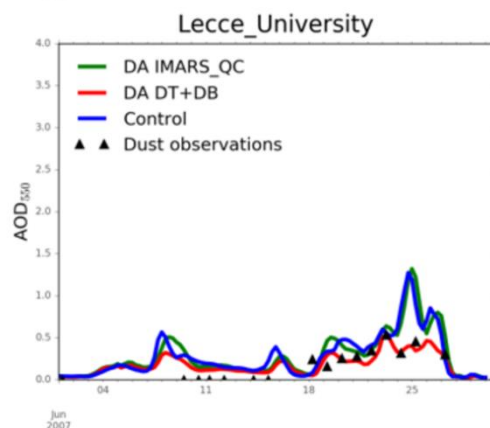
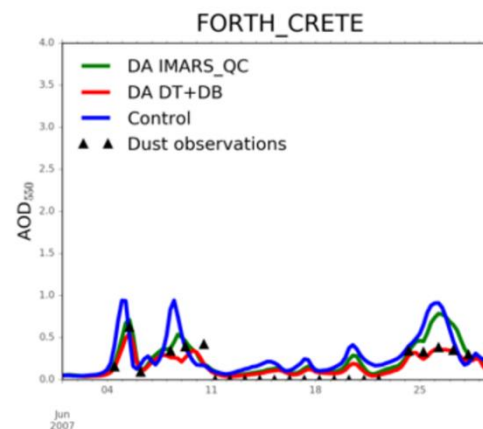
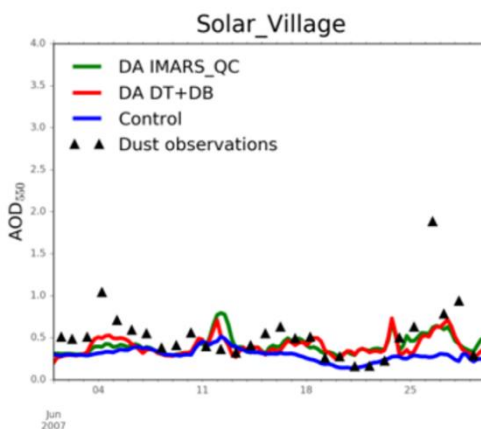
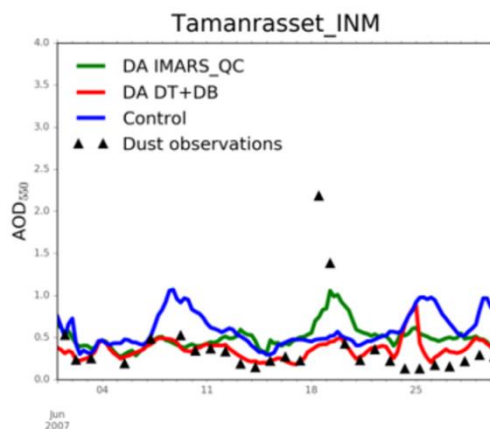
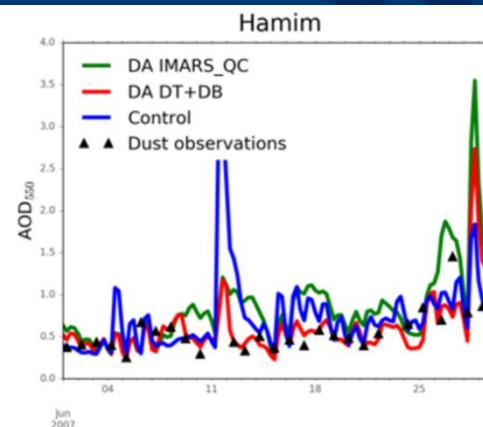
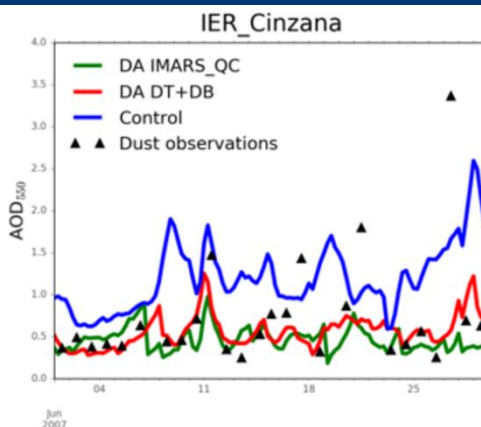
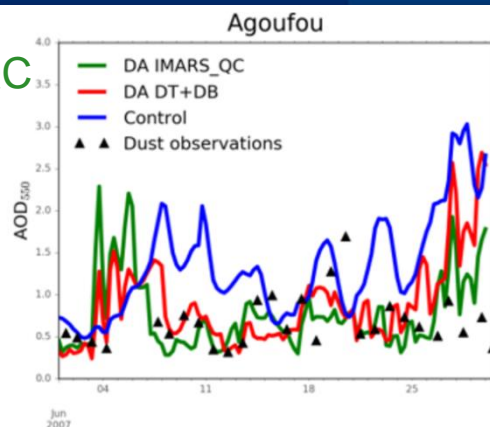
IMARS



Comparison with AERONET



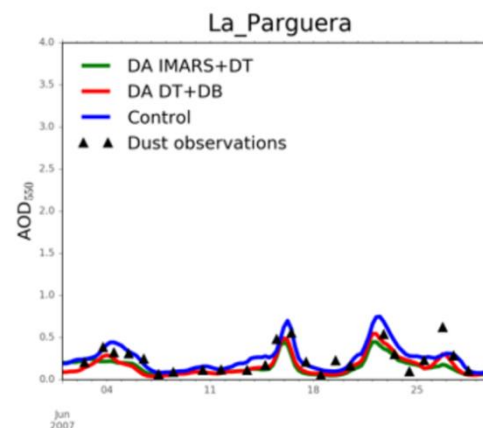
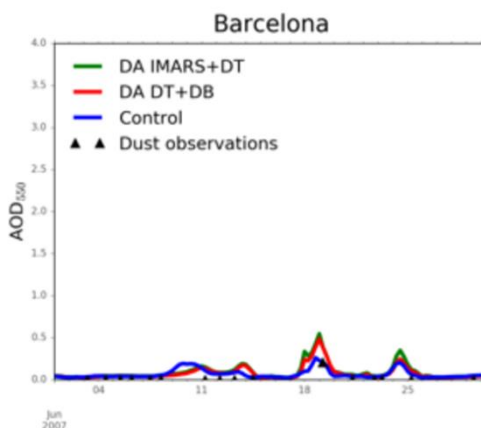
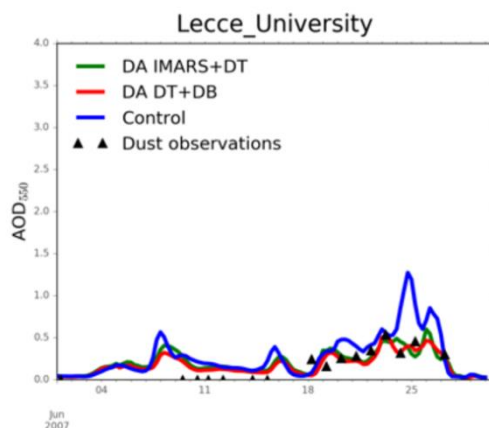
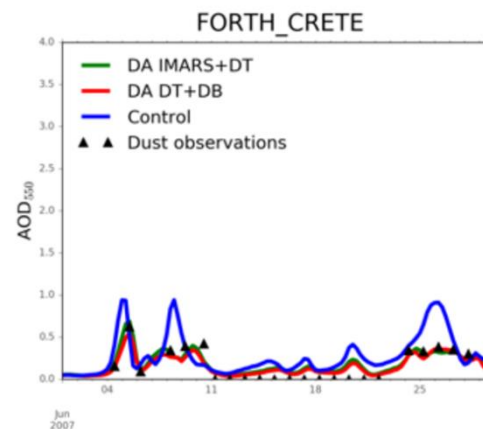
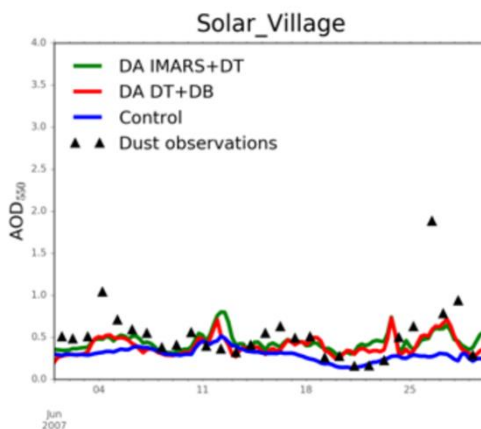
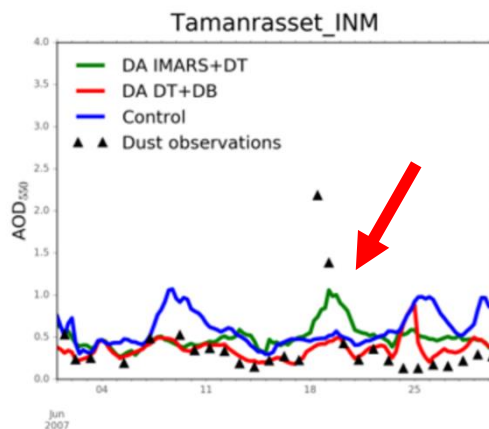
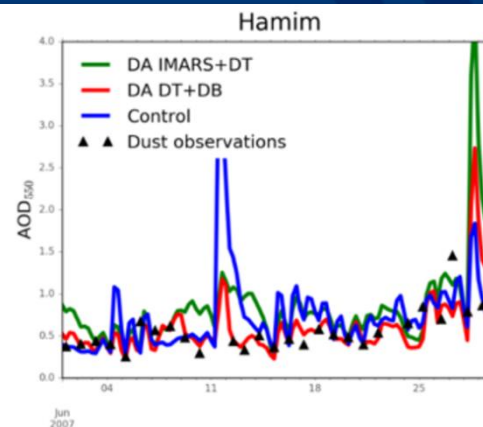
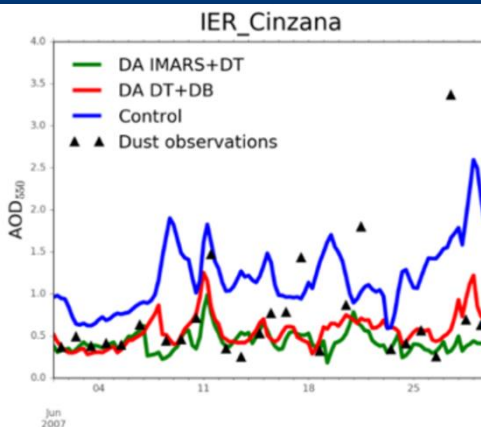
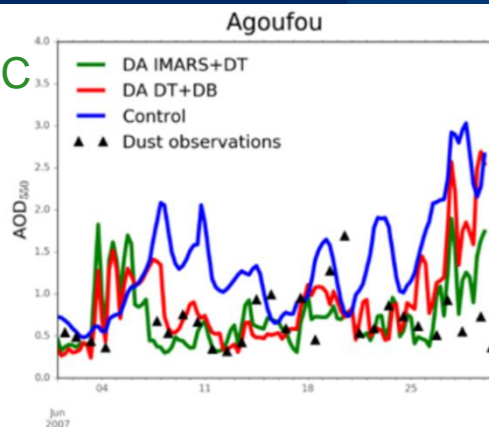
IMARS_QC



Comparison with AERONET



IMARS_QC
+
DT



- IASI dust AOD data can be ingested in the BSC assimilation system;
- Preliminary tests show some evidence of a positive impact of the IASI IMARS dust product over land. Longer simulations during a period, with full data availability and bug-free retrievals will tell us more, and allow for a thorough validation;
- The project has only just started but the interaction between product developers and assimilation team has been already fundamental and useful to both.



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Thank you!